The Fishery for Lumpfish *(Cyclopterus lumpus)* in Newfoundland Waters

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by

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ABSTRACT

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The lumpfish roe fishery in Newfoundland has expanded from only 21 tonnes of roe landed in 1970 to 2048 tonnes landed in 1986 and an estimated 3056 tonnes, with a value of over 11 million dollars, landed in 1987. This report provides background information regarding the nature and development of the lumpfish roe fishery in Newfoundland and summarizes landing statistics and available biological data. Information on length composition, sex ratio, age composition, roe yield, migration studies and catch per unit effort for lumpfish caught commercially in Newfoundland waters are presented where available.

RÉSUMÉ

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À Terre-Neuve, le niveau d'exploitation des oeufs de lompe est passé de 21 tonnes d'oeufs débarquées en 1970 à 2 048 tonnes en 1986; les débarquements estimatifs en 1987 sont fixés à 3 056 tonnes d'une valeur de plus de 11 millions de dollars. Le présent rapport contient des données historiques sur la nature et le développement de l'exploitation des oeufs de lompe à Terre-Neuve et résume les statistiques sur les débarquements et les données biologiques disponibles. On présente des données sur la composition par longueurs, la proportion relative des sexes, la composition par âges, le rendement en oeufs, les études sur la migration et les prises par unité d'effort de lompes capturées par les pêcheurs commerciaux dans les eaux terre-neuviennes.

INTRODUCTION

From a modest beginning of only 21 t of roe landed in 1970, the Newfoundland lumpfish roe fishery has expanded considerably in recent years with preliminary figures for 1987 indicating some 3,056 t of roe landed with a landed value of over 11 million dollars. This lucrative fishery has generated increased fishing effort in recent years and now provides a substantial source of income in spring and early summer for many inshore fishermen. This paper provides background information regarding the nature and development of this fishery in Newfoundland, its landings and available biological data. It is hoped that the information assembled here will be useful in determining needed areas of research and in considering any future regulatory and management strategies for this fishery.

GENERAL DESCRIPTION AND BIOLOGY OF LUMPFISH (CYCLOPTERUS LUMPUS)

The lumpfish (Cyclopterus lumpus L. 1758) is the only species of the genus Cyclopterus. In Europe they are commonly referred to as lumpsucker, with other common names including henfish, seasnail, lump, paddle-cock and poule de mer. The lumpfish is distinguished by its stout form with a dorsal hump that conceals the first dorsal fin. It has a scaleless tough leathery skin covered with hard wart-like tubercles of various sizes. The pelvic fins of this species are modified and surrounded by a circular flap of skin forming a sucking disc which enables the fish to adhere to the bottom or to floating objects in the ocean. Its form and structure suggest a fish of sluggish habits. The colour of lumpfish is variable ranging from blue, bluish-grey, to greenish and brownish with the belly often yellowish or whitish, except in breeding males when it is red. Males are generally smaller than females of the species. A more detailed description of C. lumpus can be obtained in Leim and Scott (1966) and in Davenport (1985).

It is often assumed that lumpfish are primarily bottom dwelling on rocky near-shore areas, however, several studies referred to in Davenport (1985) have indicated that lumpfish are semipelagic, spending much of their adult lives in the pelagic zone far from land. Little is known of the offshore distribution of this species, however, the distribution of lumpfish in its coastal breeding zones is known (Fig. 1). It is widely distributed on both sides of the North Atlantic. On the western side, this species is distributed from southwestern Greenland in the north, into Hudson Bay, along the coast of Newfoundland and Labrador, New Brunswick, Nova Scotia and extending as far south as Chesapeake Bay (37°N). On the eastern side, lumpfish occur in southeastern Greenland, Iceland and as far north as Svalbad. They are distributed in the Barents Sea, White Sea, along the Norwegian, Danish, Dutch, Belgian, United Kingdom, French, and Spanish coasts and as far south as the northern coast of Portugal.

Lumpfish move inshore in the spring and early summer to spawn in shallower coastal waters and return to deeper waters offshore in late summer and early fall (Collins 1976). Davenport (1985) reported that males arrive in coastal spawning areas before the females and establish territories. Females lay their eggs in a large spongy mass in several batches at intervals of 8-14 days on rocky bottom areas overgrown with kelp and other marine plants. The number of

eggs produced by a female may be as high as 400,000 in the largest fish, with 100,000 being closer to the average for spawning females (Davenport 1985). After fertilization, males aerate the eggs and guard against predation. A more detailed account of studies into lumpfish spawning, reproduction and fecundity can be found in Davenport (1985).

Statistics on international catches of lumpfish are not readily available since the major product, salted roe, is generally not differentiated from roe obtained from other species to be used as caviar. The only country specifying lumpfish roe in FAO[1] statistics is Iceland, with a reported production of 1913 t in 1984 and 1685 t in 1985 of salted and processed lumpfish roe. This compares with 938, 1225, and 2048 t of roe landed in Newfoundland in 1984, 1985, and 1986 respectively. Iceland is considered a major producer of lumpfish roe and Thorsteinsson (1981) estimated that country supplied about 70% of world sales. Thus, Newfoundland is currently probably one of the world's major suppliers of lumpfish roe.

HISTORICAL REVIEW OF THE NEWFOUNDLAND LUMPFISH ROE FISHERY

The presence of lumpfish in the coastal waters of Newfoundland and Labrador have been known for some time (Cox, 1920; Cox and Anderson, 1922). Templeman (1966) reported the moderate abundance of this species in Newfoundland coastal waters in spring and early summer and that this reportedly tasty fish (preferably the smaller redish males) were eaten at a couple of Newfoundland communities. Results of a survey conducted in 1968 and 1969 by the Newfoundland Department of Fisheries and Agriculture Research Commission and reported by Collins (1976) indicated that lumpfish were generally distributed around the whole of insular Newfoundland and most of coastal Labrador and that large concentrations occurred in many areas. The survey revealed that, in the past, lumpfish had been used for various purposes ranging from human consumption, food for dogs and pigs and bait for lobster pots. The flesh of the male was reported eaten in at least seven Newfoundland communities and in some areas was considered a dish superior to herring, mackerel, or even salmon.

Even though catches of lumpfish incidental to other fisheries, especially the cod trap and salmon net fisheries, are a common occurrence in spring and early summer (Allan 1978), the lumpfish had generally been viewed by fishermen as a nuisance and of little or no economic value. It was not until 1969, as a result of efforts by the Provincial Department of Fisheries and Agriculture Research Commission, that a commercial fishery for female lumpfish began at several locations around Newfoundland (Collins 1976). This fishery developed around the utilization of lumpfish roe for export to Germany to be used in the production of caviar. The roe was semiprocessed in a brine solution and exported to Germany in barrels for processing into the final product.

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[1]Food and Agriculture Organization of the United Nations

The Provincial Department of Fisheries became actively involved in promoting and developing the lumpfish fishery throughout the Province between 1977 and 1983 (Allan 1978; Warren 1980; Sturge 1980; Blackwood 1982a and 1983). Efforts to expand and develop this fishery included: exploratory fishing to locate commercial concentrations of lumpfish throughout Newfoundland and Labrador, demonstrations and technical assistance in harvesting and processing methods in various areas of the Province, collection of some biological information pertinent to the development of the fishery, assistance to processors in producing a more finished product and study into the further utilization of unused carcasses, and assistance to industry in monitoring market conditions.

Since its beginning in the late sixties and early seventies, the Province's lumpfish roe fishery has shown a general trend of continued expansion and progress as indicated by the roe landings given in Table 1. From a modest beginning of only 21 t with a landed value of only $5,000 in 1970, the fishery expanded to 2,048 t with a value of almost 3 million dollars in 1986. In 1987, strong markets and sharp increases in the price paid to fishermen for lumpfish roe (as high as $1.80-$2.00 a pound compared to only 65 cents in 1986 and 35 cents in 1985) have generated increased fishing effort and landings, with preliminary figures indicating landings of 3,056 t valued at over 11 million dollars. The fishery now provides a substantial source of income in the spring and early summer for many small vessel inshore fishermen when the inshore cod fishery is not very active and for those fishermen without a lobster or salmon licence. In fact, it is suspected that much effort has been diverted from other fisheries to the lumpfish fishery, especially from the lobster fishery (T. Donahue, Stat. Branch - pers. comm.). Indeed, the landed value for lumpfish roe in 1987 will most likely surpass those of such traditionally high priced species as salmon and lobster.

OVERVIEW OF THE NEWFOUNDLAND LUMPFISH ROE FISHERY

The Newfoundland lumpfish roe fishery is exclusively an inshore fishery conducted primarily by small vessels less than 35 feet in length and to a lesser extent by vessels between 35 and 65 feet long (Table 2). As indicated by landings of roe over the past ten years (Table 3), the fishery begins in April and ends in July on the Province's south coast (Div. 3Ps), with 87% of the landings occurring in May and June. The fishery on Newfoundland's east and northeast coast (Div. 3K and 3L) occurs somewhat later, not getting fully underway until May with most landings (93%) occurring in May and June and the fishery ending in July, apart from some insignificant landings in August.

A summary of Newfoundland lumpfish roe landings by NAFO Division over the past ten years is given in Table 4. Up until 1977 the main fisheries occurred in Div. 3K, 3L and 4R at such areas as Cooks Harbour and Wesleyville (Allan 1978). Compared to landings during 1977-79, average landings of roe in Div. 3K and 3L were substantially lower between 1980 and 1984, with increased landings occurring in these areas in 1985 and 1986 (landings of 434 t in Div. 3K and 462 t in Div. 3L in 1986). A commercial lumpfish roe fishery did not begin on the Province's south coast (Div. 3Ps) until 1978. Landings of roe have remained high in this area since 1980 (average of 450 t per year between 1980 and 1986), with some 650 t landed in Div. 3Ps during 1986. Landings to date in Div. 2J

(southern Labrador coast) have been negligible. A summary of Newfoundland lumpfish roe landings by Statistical Area for 1982-86 is given in Table 5.

The lumpfish fishery in Newfoundland is primarily a gillnet fishery, however as previously mentioned, some incidental catches do occur in such gears as cod traps and salmon nets. Gillnets constructed of monofilament nylon webbing with stretched mesh size of 10½" (267 mm) or 11" (279 mm) are used to prosecute this fishery. Fishermen normally set these nets in depths ranging from 2-18 fathoms (3.6-32.9 m) preferably on hard or rocky bottom areas which have an abundance of kelp and seaweed. Sturge (1980) reported claims by fishermen that at the beginning of the season lumpfish are most abundant in depths of over 5 fathoms (9.1 m), whereas later in the season during spawning they are found mostly in depths less than 5 fathoms (9.1 m). Because of the unique morphology of the lumpfish, it does not "gill" well in nets and becomes captured mainly by becoming rolled up and entangled in the gillnets as opposed to meshing (LeGrow 1968; Sturge 1980; Blackwood 1982b). Being a weak swimmer, once it becomes entangled, the lumpfish cannot tear itself away from the net very easily. Because the fish are normally not meshed, the hauling process causes many to escape. Blackwood (1982b) estimated the retaining efficiency to be only 66% based on underwater observations. For a more detailed description of the operation and type of gillnet used, see Sturge (1980).

The Newfoundland lumpfish fishery to date has been based almost exclusively on the sale of roe (Table 1). Between 1978 and 1981 an average of 170 t of carcasses per year were landed at prices of less than two cents per pound. Landings of carcasses have been negligible since 1982. The low demand for lumpfish carcasses to be used for meal and for reduction purposes is attributed to a high water content and low protein and oil yields (Paradis et al. 1975; Blackwood 1982a; Davenport 1985). Results of studies by the Provincial Department of Fisheries regarding the use of lumpfish carcasses as bait for groundfish longlines and lobster pots were also not very promising (Blackwood, 1982a). Because of this low demand for carcasses, it is the normal practice for fishermen to extract the roe sacs (ovaries) from females while at sea and to discard female carcasses and males before returning to shore. Because of their small size, male lumpfish normally escape capture by the 10½"-11" mesh gillnets used (Thorsteinsson 1981) and when caught are normally released alive by fishermen (G. Blackwood, pers. comm.). Thus, nominal catch statistics are not directly available for the lumpfish fishery and, unless some profitable use is found for carcasses, this situation is not likely to change in the near future.

SUMMARY OF AVAILABLE BIOLOGICAL DATA FOR LUMPFISH CAUGHT COMMERCIALLY IN NEWFOUNDLAND WATERS

LENGTH COMPOSITION

The lumpfish has marked sexual dimorphism, with males being much smaller than females (Davenport 1985). Lumpfish found in Newfoundland waters are considered to grow as large as those in other parts of the world (Collins 1976). Leim and Scott (1966) make reference to one female specimen measuring approximately 60 cm, caught in the Northwest Atlantic and stated that European specimens reached approximately 61 cm in length. Blackwood (1982a) reported

that 4 fish measuring 60 cm and 1 measuring 64 cm were measured during tagging operations at Grand Bank in 1981.

The only commercial length sampling of lumpfish conducted by this Department consisted of 460 measurements (10 males and 450 females) of fish caught by fishermen using regular 10½"-11" mesh gillnets set in 4-8 fm of water during May, 1979 in the Valleyfield area of Bonavista Bay (Kean 1979). Males sampled ranged from 31 to 39 cm with an average of 35.5 cm, while female specimens ranged from 36 to 53 cm averaging 44.28 cm (Fig. 4).

Length measurements of female lumpfish collected during a sampling program conducted by the Provincial Department of Fisheries in 1981 at various locations in Newfoundland and as recorded in Blackwood (1982a) are compared to those collected by Kean (1979) in Table 6. On the island portion of the Province, female lumpfish ranged from 35 to 64 cm with an average length of between 40.6 and 49.4 cm. However, a sample of 23 fish measured at Cartwright, Labrador were much smaller than those collected around insular Newfoundland, with lengths ranging from 25 to 37 cm and an average length of only 30.3 cm.

Blackwood (1982a) reported that several lumpfish measuring 3-5 cm were recorded at various locations around insular Newfoundland, but that no fish in the 6-34 cm range had been taken even during experimental fishing operations with a range of mesh sizes being used. He noted reports from fishermen that lumpfish found around Newfoundland shores seemed to be either the large commercial size or extremely small individuals normally seen attached to ropes or seaweed. This apparent absence of intermediate size lumpfish was attributed to a peculiar life cycle involving the hatching and development of lumpfish to a certain size in near-shore areas, its migration to deeper waters offshore and its subsequent return to shore to spawn when sexually mature. Davenport (1985) also referred to studies indicating this general type of life cycle in lumpfish in other parts of the North Atlantic. These studies, consisting of observations of gut contents, tagging results and numerous pelagic reports, indicate that adult lumpfish are largely pelagic living in the upper 50-60 m of the ocean, often over abyssal depths and that they remain pelagic until the winter before spawning at which time there is a gradual switch to the demersal habit. The pelagic existence of lumpfish in Newfoundland waters is substantiated by the occurrence of lumpfish, at times in large numbers, in midwater trawl catches during offshore capelin surveys by this Branch (J. Carscadden, pers. comm., Department of Fisheries and Oceans, Science Branch, P. O. Box 5667, St. John's, Newfoundland A1C 5X1).

The length composition of male and female lumpfish caught using otter trawl on a cruise of the R.V. WILFRED TEMPLEMAN during Feb.-Mar., 1987 in Subdiv. 3Ps is shown in Fig. 5. Males were generally smaller than females with an average length of 30.2 cm compared to an average length of 38.2 cm for females.

SEX RATIO

The sex ratio of lumpfish in inshore waters is obscure since the fishery is geared towards the production of roe and thus is aimed at the capture of

females. The normal practice of fishermen to extract the female roe sacs while at sea and to discard carcasses and males does not lend itself to the ready collection of sampling data. Sexed samples collected by Kean (1979) from commercial fishermen in the Valleyfield area indicated a ratio of 10 males to 450 females measured (i.e. 2.2% males by numbers).

AGE COMPOSITION

There are no published data on the age composition of lumpfish in Newfoundland waters. Because of a lack of scales, lumpfish cannot be aged by this means. Cox and Anderson (1922) reported a limited degree of success using vertebrae which had been stained and partially cleared to age lumpfish caught in Maritime waters. However, because of the cartilaginous nature of the vertebrae and their very faint markings, the authors were not totally confident to their age readings and admitted that they could not be regarded as totally correct. Blackwood (1983) attempted to use vertebrae as a means of ageing lumpfish from Newfoundland waters, but was not successful due to difficulties in interpreting irregularities in patterns on the vertebrae. He also reported trying otoliths as a means of ageing, however, had difficulties involving the interpretation of non-distinct rings in the center portion of the otoliths.

Thorsteinsson (1981) successfully used otoliths in determining the age of lumpfish in Icelandic waters. He reported that lumpfish otoliths were very small compared to those of gadoid fishes, being only .3-.5 mm long in the first year and seldom reaching 2.0 mm in mature fish. Their extremely small sizes has contributed to lumpfish age reading difficulties. A summary of mean lengths at age as reported by Thorsteinsson (1981) for spawning females from commercial gillnet catches in Icelandic waters between 1976-79 is given in Table 7. Although detailed numbers at length and age caught were not given, percentage age composition presented graphically by Thorsteinsson (1981) indicated that most individuals captured by this fishery were between 5 and 9 years old, with only a small percentage of individuals between 10 and 13 years occurring. Size ranges of female lumpfish caught commercially in Newfoundland waters appear similar to those caught around Iceland. Although it is not certain how mean lengths at age would compare, it is likely that the Newfoundland gillnet fishery similarly is directed toward a variety of year-classes. Age determination from otoliths for both male and female lumpfish from the North Sea and in the Baltic are given in Bagge (1964). These readings indicated a slower growth rate in males than in females and that most growth in length occurs before maturity with a slower rate of growth in the spawning population.

ROE YIELD

Because of the nature of the lumpfish fishery which is geared toward the sale of roe, catch statistics are presently recorded in terms of quantities of roe landed and not in whole round weight as is the case for most fisheries. Since the roe is normally extracted at sea and carcasses discarded, the collection of information regarding roe yields to be used in the estimation of nominal catches is difficult. A limited amount of work was done by this

Department on roe yields for lumpfish caught commercially by gillnets in Newfoundland waters (Kean 1979) and some information has also been collected by the Provincial Department of Fisheries (Warren 1980; Sturge 1980; Blackwood 1982a). Estimates of roe yields from these various sources are given in Table 8. These data were gathered between 1979 and 1981 at various locations around insular Newfoundland and in Labrador. Results indicate roe yields in the range of 19-31% of total body weight for the various areas and times sampled, with an average weight of roe per fish varying between .59 and 1.18 kg for fish with average weights ranging from 2.7 to 4.5 kg. These results would indicate a conversion factor from roe to whole weight somewhere between 3.2 and 5.3. An overall roe yield of about 25%, which would probably not be an unreasonable estimate, would give a conversion factor of around 4.0 which for 1986, for example, would indicate 2048 t of roe landed amounting to some 8192 t of female lumpfish caught.

The relationship of round weight versus gonad weight for a sample of 49 female lumpfish collected from the commercial gillnet fishery at Valleyfield by Kean in May, 1979 is presented in Fig. 6. This relationship ($y = 0.2704x + 0.0222$) is significant with $r = 0.64$. Blackwood (1982b) also reported a significant linear relationship between whole and gonad weight for samples collected at Codroy during 1981. The intercept of this relationship is close to zero and the slope is not inconsistent with the roe yield value of 25% stated above.

From the same samples collected by Kean (1979), the relationship between length and weight (Fig. 7) appears linear ($y = 0.1993x - 4.5476$, $r = 0.76$) for the range of lengths observed (37-50 cm). These results are also similar to those reported by Blackwood (1982b) and would indicate that percentage roe yield does not vary with length of fish, at least for the size range observed. Thorsteinsson (1983) also found that the gonadal-somatic index (i.e. weight of gonads/total weight) did not change with increase in size for females caught on spawning grounds around Iceland. The size of fish in his samples ranged from 34 to 51 cm which is very similar to the size range of fish in the samples collected by Kean (1979).

Factors such as time and area caught probably affect roe yields in lumpfish. Blackwood (1983) reported on a study undertaken at Grand Bank during 1983 which indicated that roe yields from the fishery in this particular area did vary between April and June, with maximum yields occurring between late May and early June. Thus, it seems that fish entering the fishery in April are not fully mature, with peak maturation during May and June,and a decrease in roe yield at the latter part of the season with an increase in the numbers of partial or post-spawners. Davenport (1985) referred to several studies which indicated that female lumpfish do not release all their eggs in one batch when spawning but lay 2-3 masses of eggs at intervals of 8-14 days which certainly could affect roe yields over the spawning season. Collins (1976) reported that lumpfish spawning was related to water temperature (with lumpfish laying their eggs when water temperatures reach 4°C), which also could affect lumpfish roe yields from one area to another. Blackwood (1982a) reported that although samples of lumpfish taken in gillnets at Cartwright, Labrador were small (i.e. less than 40 cm), they were mature, compared to lumpfish less than 40 cm taken at Catalina which tended to be immature.

There is an optimum stage of development for lumpfish eggs to be used commercially (Dewar et al. 1971; Warren 1980). The colour of lumpfish roe varies from grey-white (immature) to purple and red (mature) to reddish orange (over ripe). During their development, the eggs become larger in size until they reach maturity. When the eggs reach the over-ripe (reddish orange) stage, the membrane becomes soft and looses its elasticity and they are not suitable for caviar production.

An accurate conversion factor for use in converting landings from roe to whole weight would be useful for any future attempts at assessing this fishery. Information on roe yields at various times and areas could also be useful in terms of regulating this fishery on the basis of maximum roe yields and minimum catch of pre and post spawners.

MIGRATIONAL STUDIES

The only tagging of lumpfish in Newfoundland waters was carried out by the Provincial Department of Fisheries during the spring of 1981 and 1982. Blackwood (1983) reported on these studies which involved the tagging of 1945 lumpfish captured during the commercial fishery in various areas of the Province. The report (published in April, 1983) indicated that 44 tags, or 2.3%, had been recovered to date. Most of the tags were recovered within 10 miles of the tagging area and usually one year after tagging. Of the 44 fish recaptured, 86% were taken within 19 miles of the tagging location, suggesting that lumpfish return to the same spawning grounds each year. Blackwood reported that one fish was recaptured at the same location where it was released two years earlier which suggests that lumpfish spawn more than once. However, some instances of migrations over greater distances were reported as one lumpfish tagged at Burgeo on May 20, 1982 was recovered 160 km away at Codroy on June 4, 1982 and another fish tagged at Burgeo on the same date was recaptured at Greenspond, Bonavista Bay just over a year later. Tagging studies of lumpfish in waters around Iceland (Schopka 1974) and Denmark (Bagge 1967) also indicate that lumpfish have a strong homing tendency to the same spawning area and that they are able to spawn more than once.

CATCH PER UNIT EFFORT

Catch per unit effort (CPUE) information is presently not available for the Newfoundland lumpfish fishery through regular landing reporting systems. The nature of this primarily small open-boat fishery does not easily lend itself to the collection of effort data through any large scale reporting system such as logbooks. Although it is known that the number of fishermen and amount of effort involved in this fishery has increased dramatically in the past couple of years, especially during 1987 when exceptionally high prices for lumpfish roe has increased participation in this fishery, no figures are available as to the actual number of fishermen involved.

In a limited study of CPUE data collected at several communities in Newfoundland during 1981, Blackwood (1982b) reported that newly developed regions such as Codroy, Comfort Cove and Grand Bank appeared to have a higher

CPUE than other areas such as Catalina and Greenspond which had been fished for five years or more. He reported that landings declined drastically from 1978 to 1981 in the Valleyfield, Bonavista Bay area from more than 450,000 kg to under 50,000 kg despite evidence of increased fishing effort.

REGULATORY AND MANAGEMENT MEASURES

At present, the only restriction regarding fishing for lumpfish in Newfoundland is that an individual must be a licenced groundfish fishermen. In a detailed review of available information on lumpfish in the North Atlantic, Davenport (1985) reported that the only regulatory measures applied to the lumpfish fishery appear to be those introduced in 1976 by the Icelandic government. Thorsteinsson (1981) reported that these measures included limiting fishing time, boat size, gillnet mesh sizes and number of nets per boat. Fishermen are required to apply for a licence each year and to send in a catch report at the end of the fishing season. The main spawning season differs a little from one coastal region of Iceland to another. Based on biological data regarding peak spawning times in various areas, the shallow water lumpfish fishery in Iceland is divided into six regions with fishing being restricted to 3 months in each and the starting date varying from region to region. During a recent personal communication with V. Thorsteinsson (November 1987), he noted that regulations limiting fishing time and the number of nets have been relaxed in Iceland and are to be reconsidered. He stated that the lumpfish fishery is currently restricted to vessels less than 12 t (roughly comparable to Newfoundland vessels less than 35 ft. long) and that the minimum mesh size allowed is 10½".

Davenport (1985) found that there appeared to be little management of the lumpfish fisheries apart from the above mentioned regulatory measures used in Iceland. Thorsteinsson (1983) reports of a scheme used for some years in Iceland to give a rough idea of the future abundance of lumpfish in various regions. The method is highly dependent on the cooperation of fishermen and involves the regular length measurement of spawning females over the fishing season obtained directly by lumpfish fishermen and catch per unit effort data reported by them. Thorsteinsson reported that the modes in the length frequency distributions were easily detectable and that the abundance of fish in the length range 37-43 cm was a good indication of the abundance of fish 1.5-2.0 cm a year later. Thus, length composition data collected for females on the spawning grounds, along with reported catch per unit effort data, are used to forecast an increase or decrease in abundance of females on the spawning grounds a year or two later. These forecasts are apparently presented directly to fishermens groups early in the year prior to the start of the fishing season. Thorsteinsson (pers. comm.) was not aware of any regulatory or management measures for lumpfish by other countries in the Northeast Atlantic area.

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Table 1. Newfoundland lumpfish and lumpfish roe landings and landed value 1970-87.[a] (Landings in metric tonnes/value in $'000).

Year	Lumpfish		Lumpfish roe	
	Landings	Value	Landings	Value
1970	-	-	21	5
1971	-	-	156	33
1972	-	-	204	53
1973	-	-	153	51
1974	-	-	60	23
1975	-	-	94	41
1976	2	-	320	408
1977	13	-	503	261
1978	234	8	942	577
1979	204	8	930	619
1980	66	2	577	399
1981	190	6	846	601
1982	22	1	795	565
1983	-	-	1,068	770
1984	4	1	938	680
1985	-	-	1,225	961
1986	-	-	2,048	2,997
1987[b]	1	2	3,056	11,658

[a]1970-84 figures - Department of Fisheries and Oceans, Statistics Branch, Nfld. Region.
1985-87 figures - Department of Fisheries and Oceans, Statistics Branches, Nfld. and Gulf Regions.

[b]1987 figures are preliminary and only include landings processed by Statistics Branches as of October 20, 1987.

Table 2. Summary of 1986 Newfoundland lumpfish roe landings for NAFO Divisions 3K, 3L and 3Ps by vessel size category. (Landings in metric tonnes.)

Vessel size category	Division			Total	(%)
	3K	3L	3Ps		
Inshore (<35 ft)	380.5	404.8	624.5	1409.9	(91.1)
Nearshore (35-65 ft)	53.7	57.2	26.7	137.6	(8.9)
Total	434.2	462.0	651.3	1547.5	(100.0)

Table 3. Summary of Newfoundland lumpfish roe landings for NAFO Divisions 3K, 3L and 3Ps by month for years 1977-86. (Landings in metric tonnes.)

NAFO Division	Year	January-March	April	May	June	July	August	September-December	Total
3K	1977			65	73	8	+[a]		146
	1978			206	121	7	+		334
	1979			173	63	1			237
	1980		1	36	19	2			58
	1981	+	7	91	14	1			113
	1982		+	36	40	1			77
	1983			48	55	2	1		106
	1984			35	75	4	+		114
	1985			71	123	8	4		206
	1986		+	240	173	21	+		434
	Total	+	8	1001	756	55	5	-	1825
	(%)		(.4)	(54.9)	(41.4)	(3.0)	(.3)		(100.0)
3L	1977		+	108	128	15	+		251
	1978		1	232	118	19	6	+	376
	1979		+	257	84	5	1		347
	1980		2	34	13	1			50
	1981		1	45	5	+		+	51
	1982		2	14	6	+			22
	1983			33	12	+			45
	1984			44	71	2		+	117
	1985		+	69	219	46	9	+	343
	1986	+	5	200	171	74	11	1	462
	Total	+	11	1036	827	162	27	1	2064
	(%)		(.5)	(50.2)	(40.1)	(7.8)	(1.3)	(.1)	(100.0)
3Ps	1977								-
	1978			32	63	5	+		100
	1979		3	143	96	1			243
	1980		33	208	156	15			412
	1981		73	282	78	+			433
	1982		30	237	165	23			455
	1983		75	280	112	2			469
	1984		28	180	115	8			331
	1985		5	233	145	42	+		425
	1986		31	338	202	79	1		651
	Total		278	1933	1132	175	1		3519
	(%)		(7.9)	(54.9)	(32.2)	(5.0)	(-)		(100.0)

[a]Landings less than .5 metric tonnes.

Table 4. Newfoundland lumpfish roe landings (metric tonnes) by NAFO Division (1977-86).[a]

Year	NAFO Division						Total
	2J	3K	3L	3Ps	3Pn	4R	
1977		146.0	252.3			105.0	503.3
1978		334.4	376.2	99.9		131.1	941.6
1979		236.7	347.8	243.1		102.5	930.1
1980		56.8	50.0	411.7	28.7	29.7	576.9
1981		111.9	51.6	433.0	156.3	93.4	846.2
1982		77.1	22.5	455.8	131.5	108.1	795.0
1983		105.4	45.9	469.4	265.6	181.7	1068.0
1984		114.3	117.0	330.0	180.5	196.7	938.5
1985		206.5	342.6	426.3	88.0	162.0	1225.4
1986	.4	434.2	462.0	651.3	131.0	369.0	2047.9

[a]1977-84 figures - Department of Fisheries and Oceans, Statistics Branch, Nfld. Region.
1985-86 figures - Department of Fisheries and Oceans, Statistics Branches, Nfld. and Gulf Regions.

Table 5. Newfoundland lumpfish roe landings (metric tonnes) by Statistical Area for 1982-86.[a]

Statistical area	Year				
	1982	1983	1984	1985	1986
A	30.6	45.5	14.4	1.9	204.7
B	71.7	89.2	113.1	205.4	342.9
C	19.6	40.3	106.4	271.7	263.9
D	1.3	3.4	7.5	67.0	163.7
E	1.1	0.8	+[b]	3.6	26.7
F	-	-	-	+	7.4
G	-	-	-	-	0.3
H	91.0	103.0	71.3	150.9	392.6
I	365.0	348.2	231.7	245.7	229.6
J	131.5	264.0	204.7	118.7	152.6
K	18.8	32.0	41.1	29.7	34.2
L	6.7	44.0	32.7	22.7	40.1
M	2.8	15.0	79.0	95.8	66.2
N	57.0	82.7	36.3	12.4	119.7
O	-	-	-	-	2.3

[a]1982-84 figures - Department of Fisheries and Oceans, Statistics Branch, Nfld. Region.

1985-86 figures - Department of Fisheries and Oceans, Statistics Branches, Nfld. and Gulf Regions.

[b]Landings less than .1 metric tonnes.

Table 6. Comparison of size ranges and average lengths for lumpfish caught commercially in Newfoundland inshore waters.

Source:	Kean (1979)	Blackwood (1982a)[a]						
Year:	1979	1981						
Location:	Valleyfield	Grand Bank	Placentia	Bell Island	Catalina	Codroy	St. Anthony	Cartwright
Males								
No. measured	10	-	-	-	-	-	-	-
Size range (cm)	31-39	-	-	-	-	-	-	-
Av. length (cm)	35.5	-	-	-	-	-	-	-
Females								
No. measured	450	512	95	19	200	92	58	23
Size range (cm)	36-53	36-64	35-51	36-53	35-52	39-55	35-50	25-37
Av. length (cm)	44.3	49.4	43.8	44.1	42.9	45.4	40.6	30.3

[a]Only female measurements collected, Blackwood (1982a).

Table 7. Mean lengths (cm) at age as determined for spawning females in Icelandic waters (from Thorsteinsson, 1981).

Year	Age 5	6	7	8	9	10	11	12	No. Aged	No. Meas.
1976	38.5	39.5	42.4	43.2	46.4	45.0	51.0	52.0	143	200
1977	38.0	39.7	42.0	43.5	43.3	44.7	50.0		253	263
1978	37.8	39.9	42.3	44.3	45.0	46.6	43.6		621	150
1979	38.3	40.2	42.7	44.2	46.0	46.4	48.4		278	1088

Table 8. Comparison of estimated roe yields from various sources for lumpfish caught commercially by gillnets in Newfoundland waters.

Source	Sampling dates	Sampling location	No. of fish sampled	Av. wt. of fish (kg)	Av. wt. of roe (kg)	% roe
Kean (1979)	May 23-25/79	Valleyfield	49	4.3	1.18	27.5
Warren (1980)	May 31-June 6/79	Renews	35	4.2	.93	22
	May 28/79	Bell Island	25	4.5	1.00	22
Sturge (1980)	May 7-June 20/80	Isle aux Morts	96	3.3	.8	24
	May 5-June 18/80	Port au Port	64	3.9	.8	21
	June 2-4/80	Ship Harbour	14	3.3	.8	25
	June 19-July 4/80	Makkovik	16	3.2	1.0	31
	June 2/80	Riverhead	14	3.6	.88	24
	June 10/80	Bell Island	21	3.6	.70	19
	June 12/80	Mary's Harbour	3	2.7	.59	22
Blackwood (1982a)	May 13/81	Fox Hr., P. Bay	70	(3.7)[a]	.99	27.0
	June 1/81	Fox Hr., P. Bay	30	(3.4)	.70[b]	20.4
	May 7/81	Bell Island	19	(4.0)	.97	24.2
	May 21/81	Catalina	100	(3.5)	1.02	29.2
	June 10/81	St. Anthony	58	(3.2)	.88	27.9
	May 25/81	Codroy	100	(3.7)	.76	20.8

[a]Average wt. of fish (kg) were not given in Blackwood (1982a) but were calculated from average wt. of roe and % roe yields which were given.

[b]Blackwood (1982a) noted that some of the fish were post spawners thus roe yield was lower.

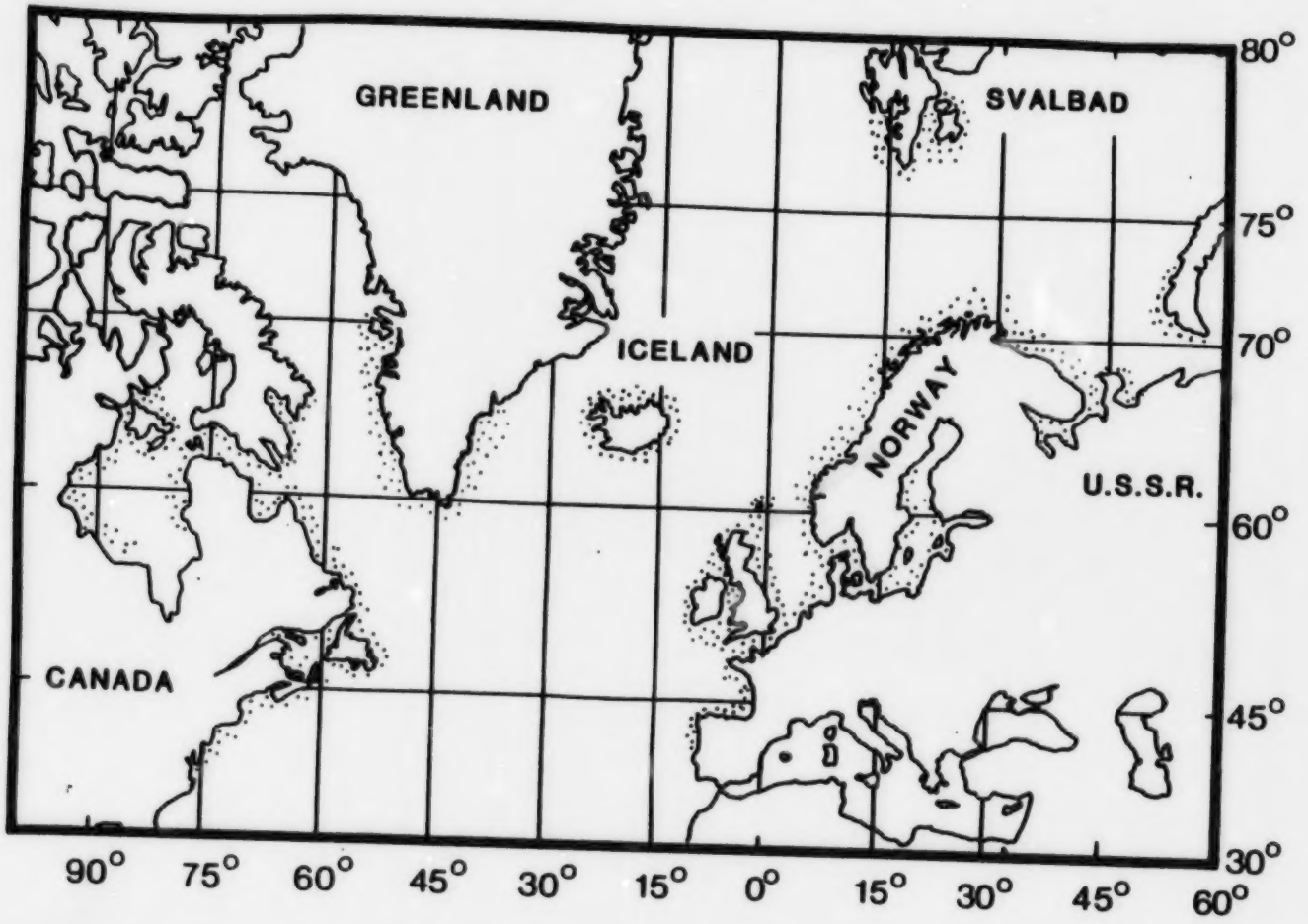

Fig. 1. Map of the coastal distribution of lumpfish (Cyclopterus lumpus). Reproduced with the permission of the Food and Agriculture Organization of the United Nations from Davenport (1985).

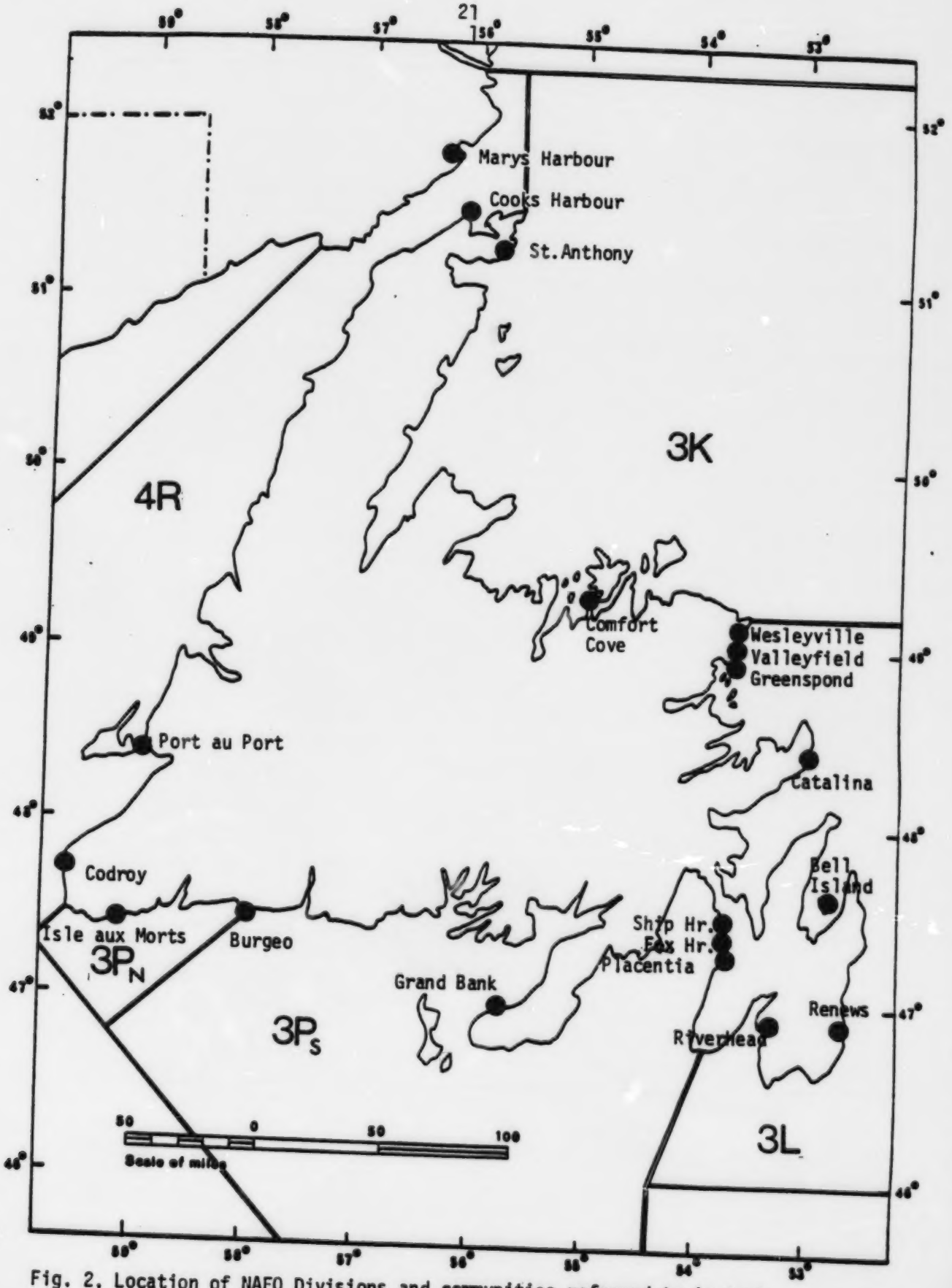

Fig. 2. Location of NAFO Divisions and communities referred to in text.

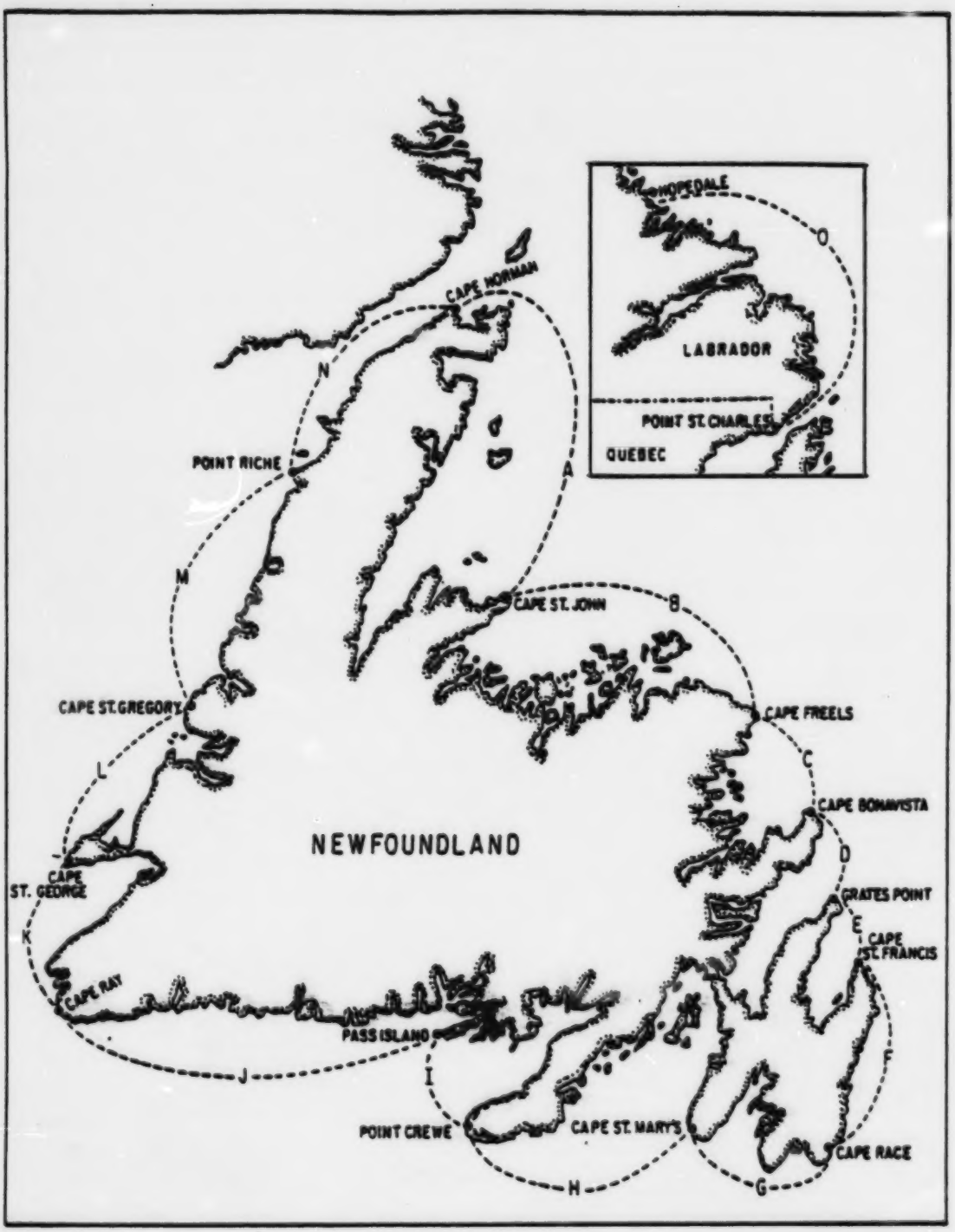

Fig. 3. Location of Newfoundland Statistical Areas.

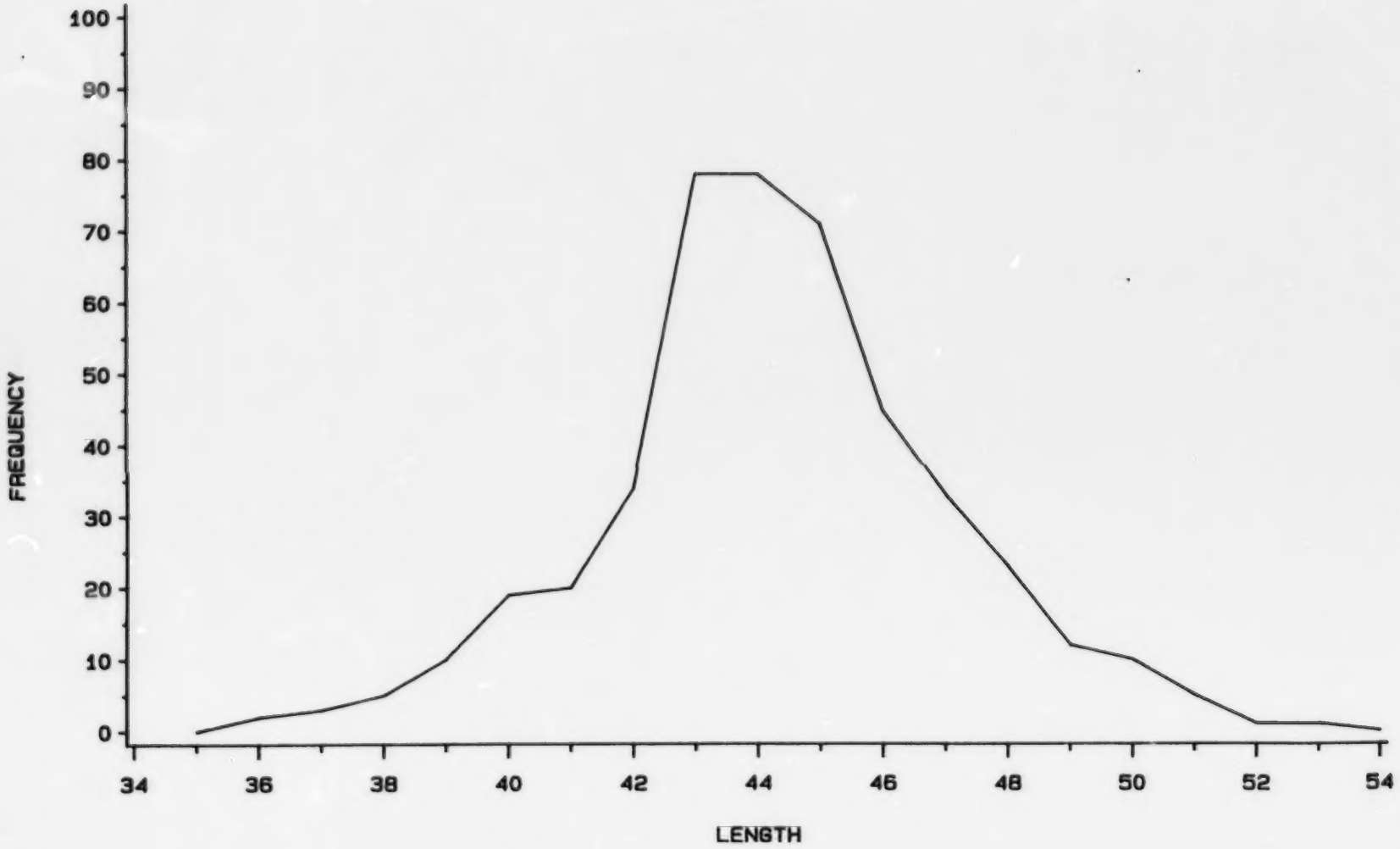

FIG 4. LENGTH FREQUENCY OF FEMALE LUMPFISH CAUGHT BY THE COMMERCIAL GILLNET FISHERY DURING MAY 1979 AT VALLEYFIELD NEWFOUNDLAND.

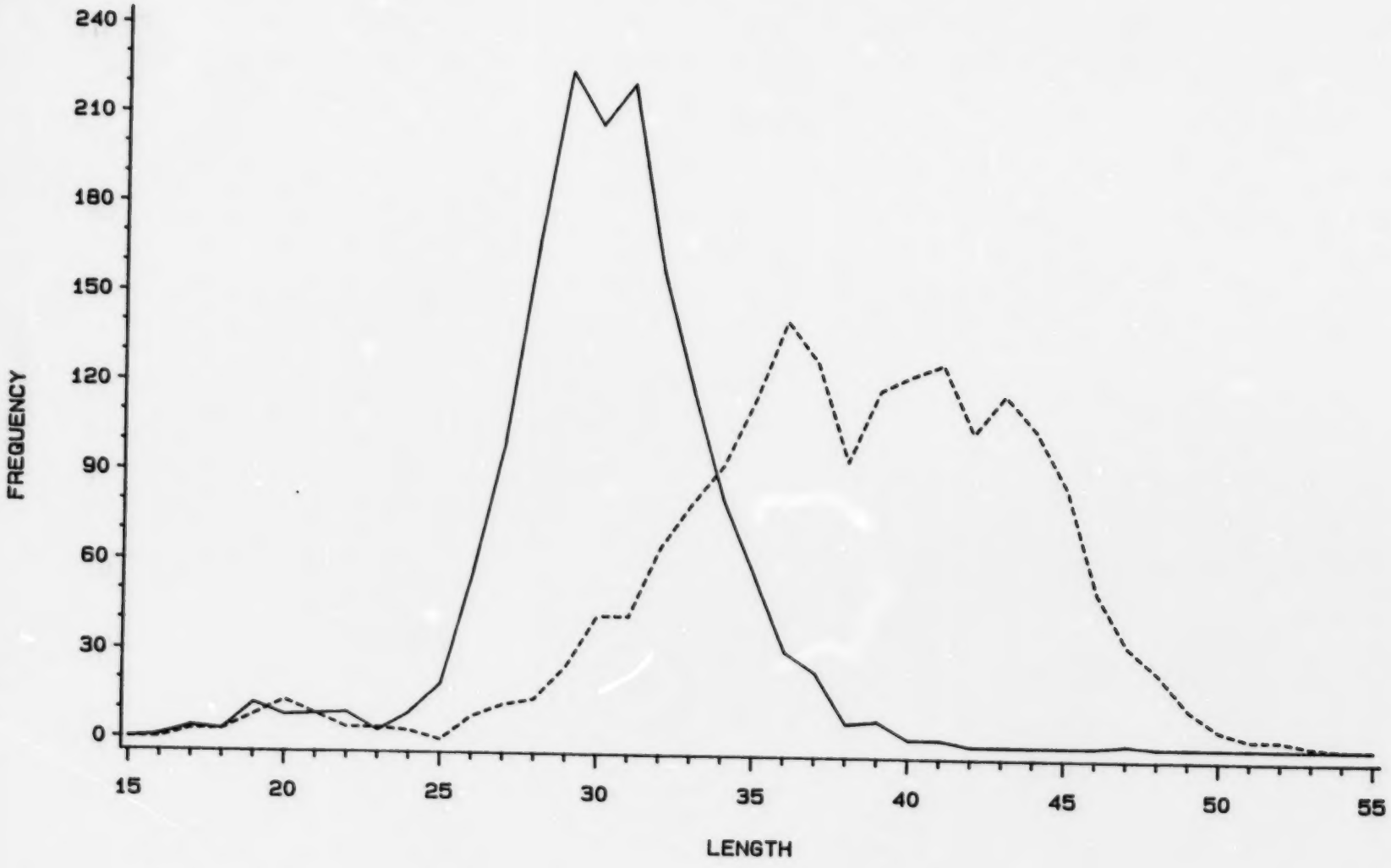

FIG 5. LENGTH FREQUENCY OF LUMPFISH FROM A RESEARCH VESSEL CRUISE DURING 1987 IN SUBDIVISION 3PS. (MALE ——— FEMALE -----)

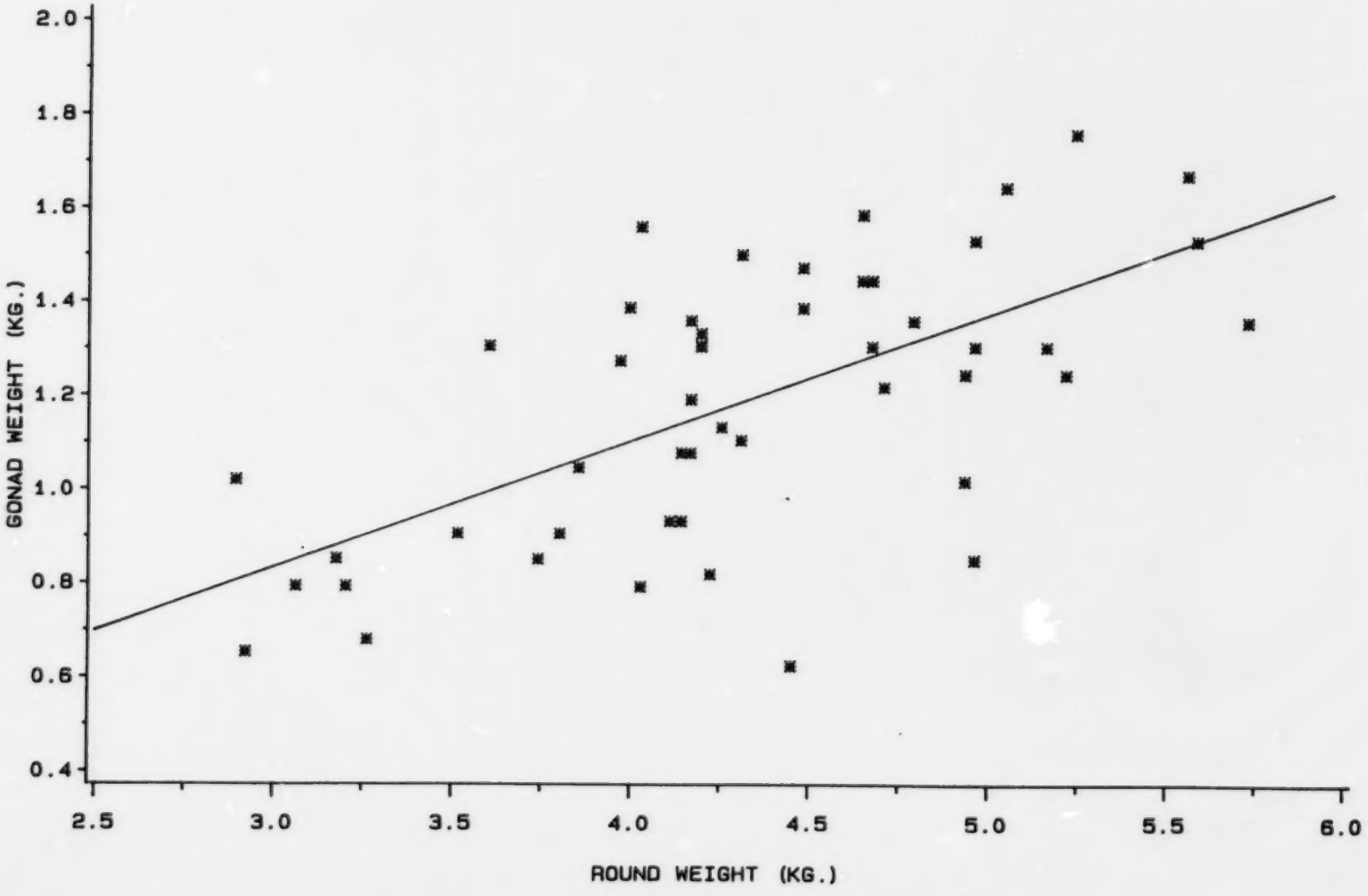

FIG 6. ROUND WEIGHT VERSUS GONAD WEIGHT FOR FEMALE LUMPFISH CAUGHT BY THE COMMERCIAL GILLNET FISHERY DURING MAY, 1979 AT VALLEYFIELD, NEWFOUNDLAND.

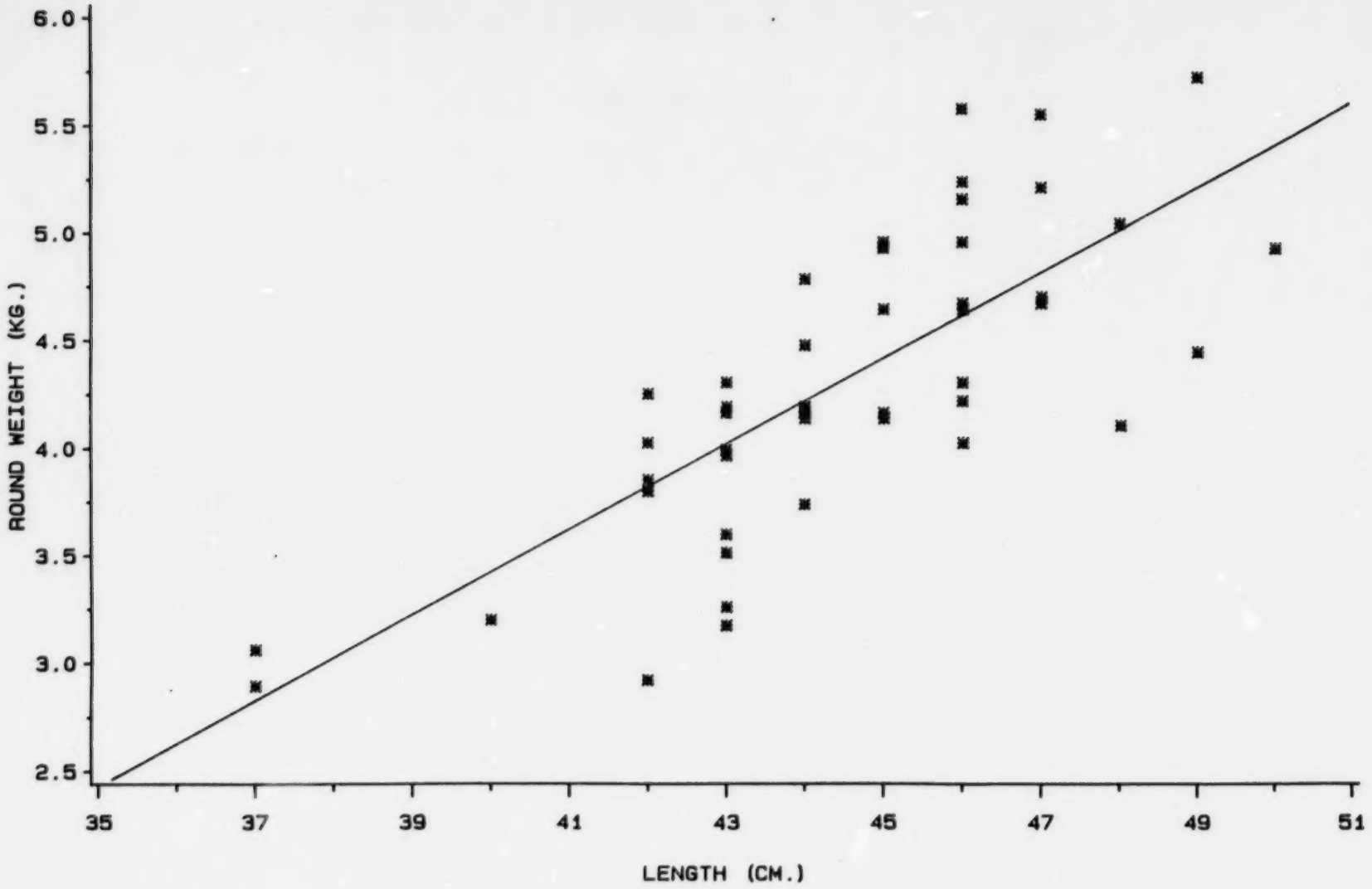

FIG 7. LENGTH VERSUS WEIGHT FOR FEMALE LUMPFISH CAUGHT BY THE COMMERCIAL GILLNET FISHERY DURING MAY, 1979 AT VALLEYFIELD, NEWFOUNDLAND.